

SEISMICALLY RESISTANT NETWORK EQUIPMENT RACK

Background of the Invention

[0001] The invention pertains generally to network racks for communications equipment, and particularly to seismically resistant network equipment racks.

[0002] Although a reliable communications system is always desirable, there can be an increased need for reliable communications during and following a crisis, especially in a heavily populated area. Some heavily populated regions of the United States and world are located in seismically active places, where earthquakes may be severe, frequent, or both. The seismic shocks of such earthquakes can be disabling to communications equipment, and, network racks, being generally tall and often heavily loaded, are particularly prone to the harsh oscillatory and undulatory displacements of earthquakes. These racks may be prone to tipping over or being severely deformed such that the communications apparatus located thereon fails to continue working.

[0003] Attempts have been made to design earthquake-resistant network racks, as seen in U.S. Patent Nos. 4,899,892 and 5,233,129. Over time, however, the industry has demanded network racks that are capable of handling heavier loading conditions without comprise or failure of the racks, to meet established industry standards when subjected to seismic stresses.

[0004] Various standards exist with respect to network rack performance and zoning. For example, various regions of the United States and/or world have been designated as Zone 1, 2, 3, or 4, wherein a Zone 4 region is assessed to face the risk of frequent and/or severe earthquakes, while a Zone 1 region is generally thought to be a

very unlikely site for an earthquake to be felt. There is a need in the industry for seismically resistant racks, particularly those meeting standards for Zone 4 regions.

[0005] Typical seismic testing involves a loading configuration on the network rack meant to simulate the loading imposed by the presence of typical electrical and connector equipment that would probably be disposed there in actual working conditions, and then applying a dynamic test by anchoring the rack to a movable plate that can simulate displacements corresponding to an earthquake. One measurable criterion by which it is determined whether a particular rack is compliant, with a maximum load condition, is whether the top channel of the rack is deflected during the shake test by no more than three inches at its greatest point of deflection and whether the top channel subsequently returns to within one-quarter inch of its original position. Since the test applied by the movable plate is generally a one-dimensional test, the rack must generally be rotated 90° and re-anchored to the plate to subsequently test the rack in the perpendicular direction. Another “customer” criterion is whether a seismically rated rack meets the specifications set forth in EIA-310-D, which include a minimum distance between the vertical posts. Some prior efforts to adapt network racks to withstand seismic stresses have compromised this minimum distance standard.

Summary of the Invention

[0006] In accordance with the expressed industry need, there is provided a network rack designed to resist failure and meet specifications when subjected to seismic forces under typical loading conditions.

Brief Description of the Figures

[0007] Fig. 1 is a front upper right perspective view of a network rack in accordance with a preferred embodiment of the invention;

[0008] Fig. 2 is an exploded front upper right perspective view of the rack of Fig. 1;

[0009] Fig. 3 is a view of the rack of Fig. 1 with particular parts removed to expose to view portions of the rack;

[0010] Fig. 4 is an exploded view of the rack of Fig. 3;

[0011] Fig. 5 is an enlarged view of the base of the rack of Fig. 3 (with the base cover off);

[0012] Fig. 6 is a front elevational view of the rack of Fig. 3;

[0013] Fig. 7 is a left side elevational view of the rack of Fig. 3;

[0014] Fig. 8 is a cross-sectional view of the rack of Fig. 3 taken across the line 8-8 in Fig. 6; and

[0015] Fig. 9 is a cross-sectional view of the rack of Fig. 3 taken across the line 9-9 in Fig. 6.

Detailed Description of the Preferred Embodiments

[0016] This application claims priority from U.S. provisional patent application No. 60/394,972, the entire disclosure of which is hereby incorporated by reference.

[0017] The invention pertains generally to network racks for carrying electrical equipment for terminating patch cords and the like (such as patch panels) and particularly to racks intended to resist stresses induced by seismic activity. The present

invention includes several features that individually and symbiotically enhance the resistance of a network rack to seismic stresses, and thereby permit the network rack to function and pass seismic tests under very heavy loading conditions.

[0018] The cross section of the vertical posts of the rack has been strengthened to provide greater resistance to bending of the vertical posts. In particular, the cross section has been enlarged, relative to some prior designs, in both dimensions to provide a greater moment of inertia about each axis of bending. Furthermore, perpendicular flanges have been added to the ends of the cross section, relative to prior designs, to further increase the bending moment of inertia about the respective axes. High strength steel (A-607, grade 50, for example) may be used to further strengthen the posts. The larger cross section of the posts, in addition to providing an increased bending moment of inertia, simultaneously increases the throat capacity, *i.e.*, the volumetric capacity for cables running down the vertical posts.

[0019] Additionally, the seismic rack includes a long vertical mounting angle abutting each of its vertical posts. As seen in the figures, a flange of the mounting angle comes flush with a flange from each vertical post. The mounting angles strengthen the rack while allowing the inside dimension of EIA-310-D to be met. In a preferred embodiment of the invention, the mounting angle may also include a tabbed extension for attaching a building ground so that the angle may be grounded. To permit the angle to be a grounding surface, it is preferably made from a conductive material, such as cold rolled steel plated with black zinc dichromate. Also in a preferred embodiment of the invention, hash marks or other indicia may be placed at regular intervals along the

mounting angle to facilitate placing electronic equipment on the rack so that it is level and/or with particularly desired spacing.

[0020] The seismically zoned rack also includes a center bottom base and a front bottom base that are welded together with various types of weld, as shown in the figures, such as a fillet weld, a flared V-weld, and a flared beveled weld. The center box may preferably be made of 7-gauge high strength steel and acts like a center box beam between the posts when seismic forces are applied. Additionally, the front bottom base is welded to the center bottom base, the welded sides and adjoining flanges effectively creating an I-beam type structure that also provides bending resistance to seismic forces.

[0021] Preferably, in the bottom of the center box beam are base angle gussets that provide stiffening in each of the four locations where the anchors are applied, and they particularly serve to brace the angle between the corresponding vertical side of the base and the floor of the base.

[0022] Like the center box beam at the bottom, the top channel of the rack is also welded to the vertical posts in such a manner as to create an integral beam so that the top channel acts as a load-bearing beam, and thereby renders the rack more resistant to seismic stresses.

[0023] Preferred embodiments of the seismically resistant rack are shown in the figures. As seen in Figs. 1-9 generally, and particularly in Figs. 1-4, there is provided a rack designed to resist failure when subjected to seismic stresses under normal rack loading conditions. The generally rectangular rack 10 includes a base 12, a pair of upstanding vertical posts 14, and a top channel 16.

[0024] The vertical posts typically include mounting holes or other means by which to mount electrical equipment, such as patch panels, to the rack. The rack may optionally include a mounting angle 20 mounted along the vertical posts to strengthen the posts and inhibit buckling and other modes of failure particularly induced by seismic activity. The mounting angles may optionally include alphanumeric indicia, such as to represent the height of particular mounting apparatus above the base or floor. The posts may also include holes for permitting the entry or exit of cables to and from the vertical cable pathways internal to the posts. Vertical cable routing may also take place in front of the vertical posts 14. For example, cables may come down from a minimum bend radius (“waterfall”) portion 22 of an extension portion 24 of the top channel 16. There may also be doors 26 to at least partially cover such vertical cabling in front of the vertical posts.

[0025] As may best be seen in Fig. 5, the base 12 preferably includes a center base portion 30 and a front base portion 32, the center base portion extending generally between the bottom ends of the vertical posts 14 and the front base portion adjoining the front sides of both the center base portion 30 and the vertical posts 14. This construction is particularly resistant to the stresses that may be introduced to the rack 10 by seismic activity.

[0026] The center base portion 30 includes a bottom wall 40, an upstanding front wall 42 (hidden in Fig. 5), an upstanding rear wall 44, a front flange 46 extending inwardly (toward the center of the center base portion) from the top of the front wall 42, and a rear flange 48 extending inwardly from the top of the rear wall 44. Similarly, the front base portion 32 includes a bottom wall 50, an upstanding front wall 52, an

upstanding rear wall 54, a front flange 56 extending inwardly (toward the center of the front base portion) from the top of the front wall 52, and a rear flange 58 extending inwardly from the top of the rear wall 58. Additionally, the front portion 32 may also include upstanding side walls 59 and side flanges 60 to further solidify the base and provide additional resistance to seismic stresses. The various side walls may preferably include apertures 62 or cut-outs for routing cables therethrough, e.g., from one base portion to another. As seen in Figs. 1 and 2, the base 12 may preferably include a cover 64 to help retain cables therein and for aesthetic purposes.

[0027] Preferably, the center base portion 30 is welded to each of the vertical posts 14 (along the front and rear flanges, discussed below), and the front base portion 32 is welded both to the center base portion 30 (where the upstanding side walls 42 and 54 and the flanges 46 and 58 meet) and the front walls (discussed below) of the vertical posts 14. Having the posts 14 and both portions of the base all welded together provides a particularly strong base 12 that is particularly resistant to the large bending, shearing, torquing, and buckling stresses associated with seismic forces. In particular, the welded together upstanding walls 42 and 54, in conjunction with the inwardly extending flanges 46 and 58 and the bottom walls 40 and 50, effectively join to make an I-beam at the junction of the center and front base portions 30 and 32, while the upstanding walls 44 and 52, along with flanges 48 and 56 and bottom walls 40 and 50, respectively, form C-beams at the rear and front of the base 12. Preferably, the I-beam and C-beams all generally span the width between the vertical posts (notwithstanding that the front C-beam is disposed in front of the posts) without a significant break in their structural integrity, as this feature strengthens the rack considerably.

[0028] Base angle gussets 66 may preferably be used to reinforce the upstanding walls and help transfer the load on the rack to the anchors 67. A front base extension 68 may also optionally extend forwardly from the front wall 52 of the front base portion 32 to provide additional stability and strength to the base and to the rack generally.

[0029] In a preferred embodiment of the invention, as can be seen in Figs. 3 and 5 relative to the base 12 and as can be seen in Figs. 1-3 relative to the top channel 16, there are cut-outs 80 in the base and 82 in the top channel that generally match the cross-sectional shape and alignment with the vertical posts to facilitate routing cables in and out of the vertical cable pathways within the posts. This may serve to provide more direct cable connections.

[0030] Fig. 9 shows, among other things, the novel cross-sectional shape of the vertical posts 14 of the seismically resistant rack 10. As seen therein, the vertical posts 14 include an outer wall 70, a front wall 72 extending generally perpendicularly inwardly from a front edge 71a of the outer wall 70, a rear wall 74 extending generally perpendicularly inwardly from a rear edge 71b of the outer wall 70, a front transverse flange 76 extending generally perpendicularly inwardly from an inward edge 73 of the front wall 72, and a rear transverse flange 78 extending generally perpendicularly inwardly from an inward edge 75 of the rear wall 74. The outer wall 70 is generally parallel to the transverse flanges and is disposed more remotely from a vertical centerline of the symmetric rack than either of the transverse flanges. In a preferred embodiment of the invention the front wall 72 is longer than the rear wall 74 to permit cables running within the vertical posts 14 to be accessed from the rear of the rack. In a

preferred embodiment of the invention, the front wall 72 is at least 2 inches across, and more preferably at least 4 inches across, and the outer wall 70 is at least 4 inches across, and more preferably at least 6 inches across. The large cross-sectional area of the vertical post provided by these relatively large dimensions increases the cable capacity of the vertical posts while simultaneously strengthening the members and making them less prone to buckling or other deformation under seismic loads. Having the rear wall 74 be no more than about half the length of the front wall 72 permits easy access to the cables without seriously compromising the strength.